TOR heavy crawler transporter

This is a conceptual design of the TOR heavy tracked transporter, optimized for Polish terrain conditions (soft soils, forested and urbanized areas).

1. Hull and Dimensions
The design is based on a self-supporting hull with high displacement, prepared to overcome water obstacles and muddy terrain.
Length: 7.8 m
Width: 3.4 m (optimal for Polish roads and bridges)
Height (to the hull roof): 2.4 m
Total weight: approx. 35-40 tons (depending on the armor package)
Layout: Engine in front (right), driver in front (left), commander and weapons operator behind them. Rear landing compartment for eight soldiers.

2. Hybrid Drive (Serial Hybrid)
A system in which the combustion engine has no mechanical connection to the tracks – it only acts as an aggregate.
Electric motors: 2 x 450 HP (total 900 HP), high torque available from zero, which is crucial in the mud.
Generator: A compact diesel engine (e.g. Scania or MTU) that charges the batteries/powers the engines.
Advantages: Possibility of silent approach (Silent Watch / Silent Drive), lack of a long drive shaft increases the space inside.

3. Armor and Protection
A multi-layer structure in a modular arrangement was used.
Base Hull: Welded high-ductility armor steel plates.
Basic armor: Composite (ceramics + steel + aramid layers) protecting against 30 mm (front) and 14.5 mm (sides) automatic cannon projectiles.
Mine protection: V- or U-shaped bottom with internal decoupled plate. Troop seats suspended from the ceiling (shock wave reduction).
Active Protection System (ASOP): Polish laser warning sensors and smoke grenade launchers.

4. Unmanned Tower (ZSMU)
Remotely Controlled Weapons Module mounted on the roof, not intruding into the crew space.
Armament: 30 mm automatic cannon (e.g. Bushmaster II) + coupled 7.62 mm machine gun.
Optics: Optoelectronic head with third-generation thermal imaging and laser rangefinder (Polish production, e.g. PCO).
Hunter-Killer Ability: The commander can designate a target and the turret automatically locks on to it while the operator completes the previous task.

5. Specificity for Polish conditions
Unit pressure: Wide tracks (600 mm) with rubber pads for mobility on peat bogs and asphalt.
Air conditioning and filter ventilation: Suitable for operation in contaminated environments (NBC) and high humidity.

Top Secret

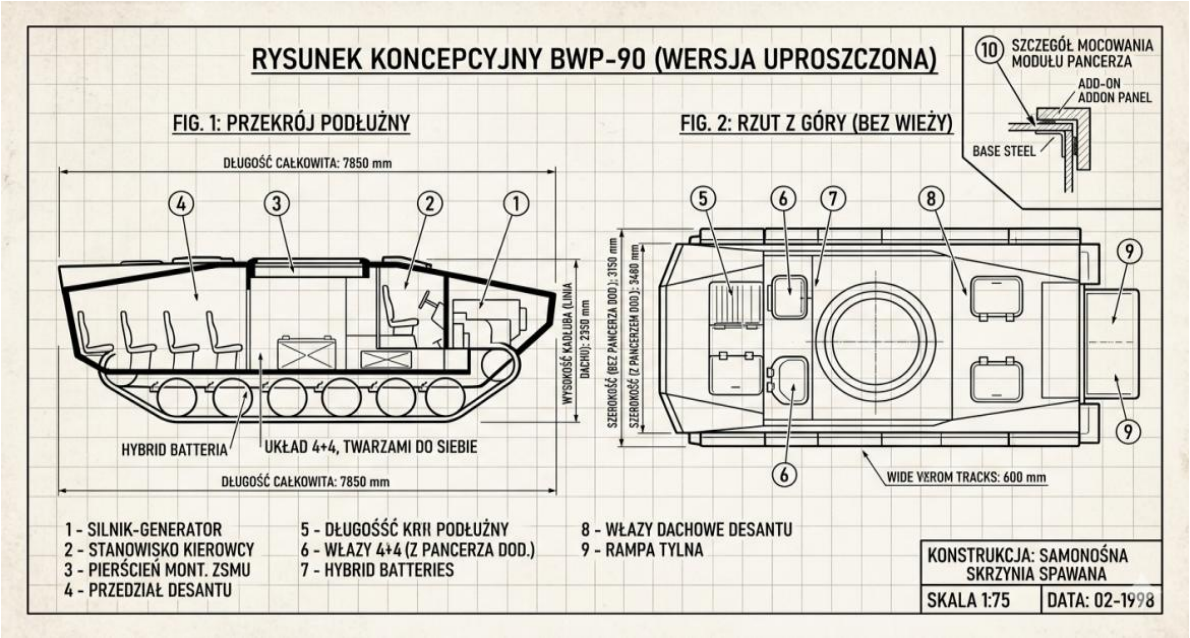
Chapter 1

External Dimensions and Overall Dimensions

1. External Dimensions and Overall Dimensions
The dimensions were selected so that the vehicle fits within the railway gauge and can move freely on civilian bridges (MLC class).
Total length: 7850 mm
Width (without side screens): 3150 mm
Width (with additional armor): 3480 mm
Hull height (roof line): 2350 mm
Ground clearance (adjustable): 450 mm – 550 mm (crucial in deep ruts and mud).

2. Hull Architecture
The hull is made as a rigid, welded box made of high-strength armored steel sheets.
Forward (Drive) Section: The right side is the insulated internal combustion engine (generator) compartment, the left is the driver's station. The bulkhead separating the engine from the crew is gas-tight and fire-resistant.
Center (Combat) Section: Space for the commander and weapons operator. Above them is a reinforced mounting ring for the unmanned turret (the so-called "basket" does not extend into the hull, saving space).

Rear Section (Airborne): A compartment with a volume of approximately 8.5 m³, accommodating 8 soldiers in two rows of 4, sitting facing each other.
Rear of the hull: Hydraulically lowered ramp with additional manually opened door (emergency exit).


RYSUNEK KONCEPCYJNY BWP-90 (WERSJA UPROSZCZONA)
FIG. 1: PRZEKRÓJ PODŁUŻNY
FIG. 2: RZUT Z GÓRY (BEZ WIEŻY)
10 SZCZEGÓŁ MOCOWANIA MODUŁU PANCERZA
ADD-ON
ADDON PANEL
BASE STEEL
DŁUGOŚĆ CAŁKOWITA: 7850 mm
HYBRID BATTERIA
UKŁAD 4+4, TWARZAMI DO SIEBIE
WYSOKOŚĆ KADŁUBA (LINIA DACHU): 2350 mm
SZEROKOŚĆ (BEZ PANCERZA DOD.): 3150 mm
SZEROKOŚĆ (Z PANCERZEM DOD.): 3480 mm
WIDE VEROM TRACKS: 600 mm
1 - SILNIK-GENERATOR
2 - STANOWISKO KIEROWCY
3 - PIERŚCIEŃ MONT. ZSMU
4 - PRZEDZIAŁ DESANTU
5 - DŁUGOŚŚĆ KRII PODŁUŻNY
6 - WŁAZY 4+4 (Z PANCERZA DOD.)
7 - HYBRID BATTERIES
8 - WŁAZY DACHOWE DESANTU
9 - RAMPA TYLNA
KONSTRUKCJA: SAMONOŚNA SKRZYNIA SPAWANA
SKALA 1:75
DATA: 02-1998

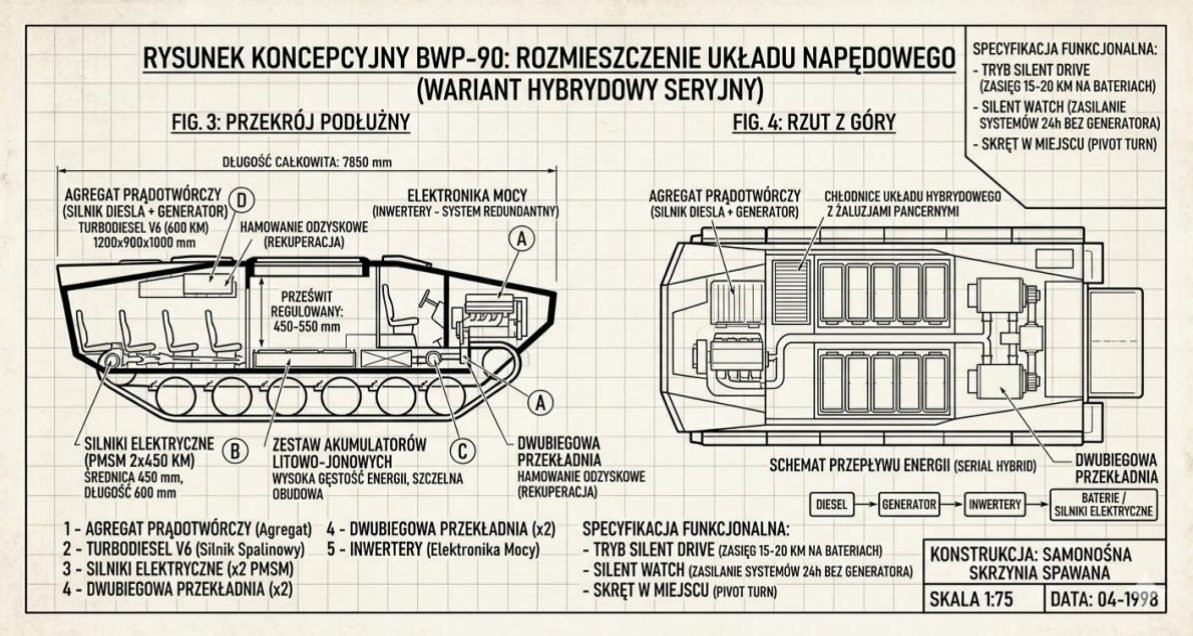
3. Armor Specifications (Layered)
A passive protection system in accordance with the NATO STANAG 4569 standard was used:
Base layer: Armoured steel (HHS) 15-25 mm thick, constituting the load-bearing structure.
Basic armor (Add-on): Ceramic-composite panels mounted on spacers (so-called layered armor).
Front: Resistance to 30mm APFSDS bullets (at a 30 degree angle).
Sides and rear: Resistant to 14.5mm and 155mm artillery fragments.
Bottom (Mine Protection): Sandwich construction with internal shock wave deflector.
Protection level: 4a/4b (explosion of 10 kg of TNT under the wheel or hull).

4. Technical Solutions of the Hull Ballistic Suit: Interior lined with high-density polyethylene spall liners that trap armor fragments upon impact.
Integrated storage compartments: The side walls of the hull feature external storage compartments for crew equipment, which serve as additional protection (so-called structural armor).
Hatches: For the driver (front, sliding).
For the commander and operator (on the upper plate).
Two roof hatches in the landing compartment (for firing or evacuation).

Chapter 2

Arrangement in the fuselage

1. Layout in the fuselage
Front (Right Side): Power unit (combustion engine + generator). Positioned at the front, it provides additional ballistic protection for the crew.
Rear/Sides (Near the drive wheels): Two independent electric motors powering the drive wheels (usually front or rear, depending on the configuration - in TOR rear-wheel drive is recommended for better traction of the landing force).
Floor/Sides: High energy density lithium-ion battery pack housed in sealed housings under the fighting compartment floor (lowers center of gravity).


RYSUNEK KONCEPCYJNY BWP-90: ROZMIESZCZENIE UKŁADU NAPĘDOWEGO
(WARIANT HYBRYDOWY SERYJNY)
FIG. 3: PRZEKRÓJ PODŁUŻNY
FIG. 4: RZUT Z GÓRY
SPECYFIKACJA FUNKCJONALNA:
- TRYB SILENT DRIVE (ZASIĘG 15-20 KM NA BATERIACH)
- SILENT WATCH (ZASILANIE SYSTEMÓW 24h BEZ GENERATORA)
- SKRĘT W MIEJSCU (PIVOT TURN)
DŁUGOŚĆ CAŁKOWITA: 7850 mm
AGREGAT PRĄDOTWÓRCZY (SILNIK DIESLA + GENERATOR)
TURBODIESEL V6 (600 KM)
1200x900x1000 mm
HAMOWANIE ODZYSKOWE (REKUPERACJA)
ELEKTRONIKA MOCY (INWERTERY - SYSTEM REDUNDANTNY)
PRZEŚWIT REGULOWANY: 450-550 mm
SILNIKI ELEKTRYCZNE (PMSM 2x450 KM)
ŚREDNICA 450 mm, DŁUGOŚĆ 600 mm
ZESTAW AKUMULATORÓW LITOWO-JONOWYCH
WYSOKA GĘSTOŚĆ ENERGII, SZCZELNA OBUDOWA
DWUBIEGOWA PRZEKŁADNIA
HAMOWANIE ODZYSKOWE (REKUPERACJA)
AGREGAT PRĄDOTWÓRCZY (SILNIK DIESLA + GENERATOR)
CHŁODNICE UKŁADU HYBRYDOWEGO Z ŻALUZJAMI PANCERNYMI
SCHEMAT PRZEPŁYWU ENERGII (SERIAL HYBRID)
DIESEL
GENERATOR
INWERTERY
BATERIE / SILNIKI ELEKTRYCZNE
DWUBIEGOWA PRZEKŁADNIA
1 - AGREGAT PRĄDOTWÓRCZY (Agregat)
2 - TURBODIESEL V6 (Silnik Spalinowy)
3 - SILNIKI ELEKTRYCZNE (x2 PMSM)
4 - DWUBIEGOWA PRZEKŁADNIA (x2)
4 - DWUBIEGOWA PRZEKŁADNIA (x2)
5 - INWERTERY (Elektronika Mocy)
SPECYFIKACJA FUNKCJONALNA:
- TRYB SILENT DRIVE (ZASIĘG 15-20 KM NA BATERIACH)
- SILENT WATCH (ZASILANIE SYSTEMÓW 24h BEZ GENERATORA)
- SKRĘT W MIEJSCU (PIVOT TURN)
KONSTRUKCJA: SAMONOŚNA SKRZYNIA SPAWANA
SKALA 1:75
DATA: 04-1998

2. Combustion Engine (Generator)
Acts as a "Range Extender".
Type: Turbodiesel V6 or R6 (e.g. Scania DC09 or MTU) with approx. 500–600 HP.
Function: Optimized for constant RPM (highest efficiency). Doesn't need to react to sudden throttle inputs, as electric motors do.
Unit dimensions: approx. 1200 x 900 x 1000 mm.
Cooling: The hybrid system requires efficient liquid coolers (separate for the diesel engine, separate for the power electronics), located on the upper hull plate with armored shutters.

3. Electric (Drive) Motors
Two permanent magnet synchronous motors (PMSM).
System power: 900 HP (2 x 450 HP / approx. 660 kW).
Torque: Approximately 2500–3000 Nm available from 1 rpm. This allows you to pull a 40-ton colossus out of deep mud without the risk of burning out the clutch (which isn't there).
Motor dimensions: Cylindrical housing with a diameter of approximately 450 mm and a length of 600 mm.
Gearboxes: Each motor has its own two-speed reduction gear (off-road and on-road).

4. Technical Specifications of the Drive
Silent Drive Mode: Up to 15-20 km of range possible on batteries alone (complete silence and no thermal footprint from the exhaust).

Silent Watch: Powering electronics, tower and surveillance systems 24 hours a day without turning on the combustion engine.
Regenerative Braking (Recuperation): When descending hills, the electric motors recharge the batteries, sparing the mechanical brakes.
Pivot Turn: Precise control – one motor spins forward, the other spins backward.

5. Power Electronics (Inverters)
Located in the upper, most protected part of the hull, they manage the flow of electricity between the generator, batteries, and engines. The system is redundant – failure of one engine allows the other to continue operation.

Chapter 3

Battery Technical Specifications

1. Battery Technical Specifications
LiFePO4 (Lithium-Iron-Phosphate) or newer LTO (Titanium) type cells were used, which are much safer (they do not explode when pierced) than standard passenger car batteries.
Total capacity: approx. 150–200 kWh (allows for approx. 15–20 km of driving in Silent Drive mode).
System voltage: 700V – 800V (high voltage reduces transmission losses and allows for fast charging from the generator).
Discharge Power: The ability to deliver enough current to momentarily boost both motors to a full 900 HP.
Cooling: Liquid (glycol), integrated with the vehicle's air conditioning system to keep the cells at an optimal 25-35°C.

2. Layout in the Hull
The batteries are not one large block, but a system of distributed modules, which increases the vehicle's survivability.
Main Location (Center of Gravity): The modules are mounted along the sides, in the lower part of the hull, but above the level of the "V" bottom. This protects them from mine explosions by the deflector structure, while also lowering the center of gravity, preventing the vehicle from tipping over in difficult terrain.
Armored cassettes: Each module (approximately 10-12) is housed in a sealed, fireproof composite cassette. If one module is hit and ignites, the system automatically shuts it down and thermally isolates it, allowing the rest to continue operating.
Floating floor: The batteries are mounted on vibration isolators, which protects them from shocks when driving on bumpy surfaces and the shock wave of an explosion.

3. Security and Integration
Ballistics: The battery modules are separated from the crew and landing compartments by an internal armored bulkhead.
Fire extinguishing system: Dedicated installation with a suppressant (e.g. aerosol) inside the battery cassettes.

Top Secret

Battery Management System (BMS): An intelligent system monitors each cell. If the energy level drops below 20%, it automatically activates the diesel generator to recharge the system.

4. "Silent Watch" function
Thanks to such a power bank, TOR can stand in ambush with the combustion engine turned off for approximately 24-48 hours, powering:
Unmanned 30 mm turret.
Radars and optoelectronic heads.
Communication systems and air conditioning.
Result: The vehicle is invisible to enemy thermal cameras (cold hull).

Chapter 4

The energy management system and on-board computer in the TOR transporter are the vehicle's "brain," integrating the hybrid drive with the combat systems. Due to the specific Polish conditions (requirement of high resistance to EW interference – Electronic Warfare), the system is based on a distributed architecture.

1. System Architecture (VMS - Vehicle Management System)
The system doesn't have a single central processor that would disable the entire vehicle upon impact. It utilizes a MIL-STD-1553B data bus (military standard) and a 10Gbps fiber-optic Ethernet network.
Two Main Computing Units (MCUs): One at the front (near the driver), the other at the rear (in the troop compartment). They operate in a "hot standby" configuration – if one is destroyed, the other takes over in a split second.
Operating System: RTOS (Real-Time Operating System) – real-time system, resistant to hangs and cyber attacks.

2. Power Management Unit (PMU)
This is the most advanced part of the computer, controlling the flow of 800V DC.
Intelligent Power Distribution: Automatically decides whether power flows from the batteries, the petrol generator, or both (Maximum Attack mode – full 900 HP).
Stealth Mode (Silent): The computer turns off all unnecessary power consumers, passively cools the inverters and manages the operation of electric motors so that they emit minimal noise and heat.
Predictive Diagnostics: The computer monitors the temperature of each battery and motor module. If it detects an unusual temperature increase (e.g., after shrapnel damage), it immediately shuts down that sector and redirects power to the remaining modules.

3. Crew Interface (HMI)
Each of the 3 crew members has an identical set of touch screens (12-inch, reinforced, readable in full sunlight and with night vision goggles).

Top Secret

Driver: Sees battery charge status, estimated range on electricity alone, and 360° camera views ("transparent armor" system).
Commander/Operator: Manages the turret, targeting systems and the transmission of targeting data to other units (BMS – Battle Management System).
Landing: They have their own terminal at the back, showing an external image so they know where the enemy is before exiting the ramp.

4. Computer Technical Specifications
Cooling: Liquid, integrated with the hull (radiators hidden in the armor).
Immunity (EMC): Complete shielding against electromagnetic pulse (EMP) from a nuclear explosion or microwave weapon.
Cybersecurity: Physical separation of the drive network from the external communication network (so-called Air-Gap).

5. Integration with Armaments
The TOR's onboard computer automatically adjusts driving parameters when firing from the 30mm turret. If the operator acquires a target, the computer can stiffen the electric suspension for a fraction of a second or adjust the torque on the tracks to keep the platform as stable as a table.

Chapter 5

Position Arrangement

1. Position Arrangement (1+2 Layout)
Unlike older designs, the crew sits close together, which facilitates verbal communication in the event of an electronics failure.
Driver (Front-Left): Sits lowest, in a semi-reclining position (rally ergonomics), which lowers the overall vehicle's silhouette. In front of them is a steering wheel integrated with the drive mode selection buttons (Silent/Hybrid/Boost).
Commander (Center-Right): Seated slightly higher and behind the driver, his position is the "universal command center." He has access to radios, digital maps (BMS), and surveillance drone images.
Weapons Operator/Aimer (Center-Left): Seated next to the commander, his sole task is to operate the unmanned turret using force-feedback joysticks.

2. Ergonomics and Comfort (“Sexy” solutions for the crew)
In the Polish climate (from -30°C to +40°C in a closed steel box), comfort is not a luxury, but a combat capability.
Air Conditioning and Parking Heater (Webasto): Thanks to powerful batteries, the system operates silently for several hours. In winter, the crew can sleep warm without revealing their position to the running diesel engine.
Explosion-Proof Seats: Each of the 3 seats is suspended from the ceiling on belts/frames with shock absorbers. They have no contact with the floor, which protects the spine in the event of a mine explosion (Level 4 STANAG).

Top Secret

Transparent Armor System: Crews don't need to stick their heads out of hatches. Thanks to high-resolution cameras around the hull and VR/AR goggles (or curved monitors), they see "through the metal" in 360 degrees.

3. Interface and Control (HMI)
Glass Cockpit: No analog gauges. Everything is displayed on touchscreens that can be operated with thick gloves.
Diagnostic System: The computer continuously displays the vehicle's "health." If the electric motor is overheating, the driver receives an alert suggesting a change in operating mode.
Social Compartment: Behind the commander's and gunner's seats there is a storage compartment for food rations, a water heater (so-called "boiling vessel" - crucial for long guard duty) and USB/230V sockets for charging personal equipment.

4. Safety and Evacuation
Escape Hatches: Each crew member has their own top hatch, but in the event of fire they can walk "backwards" to the landing compartment and exit via the safe ramp under the cover of the entire vehicle.
Spall Liner: The walls in the crew compartment are lined with a soft composite (Kevlar/Polyethylene) that feels like upholstery but is designed to trap armor fragments.

5. Operational Lighting
Combat Mode: Red or blue LED light inside that does not blind when using night vision and is not visible from the outside when the hatch is opened.

Chapter 6

Dimensions and Volume

1. Dimensions and Volume
The space has been optimized for the modern soldier with a backpack, bulletproof vest and ammunition.
Compartment capacity: approx. 8.5.
Section length: 3200 mm.
Usable width (between sides): 2400 mm.
Usable height: 1600 mm (allows for quick entry/exit when tilted).
Number of seats: 8 soldiers (2 rows of 4 people).

2. Layout and Ergonomics (Seats)
A face-to-face arrangement is used, which facilitates communication and preparation for leaving the vehicle.
Explosion-proof seats: Special seats with 5-point seat belts.
Suspended mounting: The seats are attached to the ceiling or side walls, not the floor. This prevents the shockwave from a mine explosion under the hull from breaking soldiers' spines.
Footrests: Folding footrests, also isolated from the bottom of the vehicle.

Top Secret

3. Communication and Situational Awareness
The soldier inside the TOR is not "blind".
Landing Screens: Two 15-inch monitors on the forward bulkhead of the compartment. They display 360-degree external cameras and a map from the Battle Management System (BMS). Soldiers know what's happening behind the ramp before it opens.
Intercom: Each station has a socket for connecting to the on-board communication system, allowing you to talk to the vehicle commander and driver without shouting over the noise of the electric motors.

4. Entry and Evacuation
Hydraulic ramp: The primary method of entry. Lowers in approximately 3-4 seconds.
Ramp Door: A door built into the ramp that opens manually (in case of hydraulic failure or when the vehicle needs to be lowered quietly).
Roof Hatches: Two rectangular hatches above the heads of the landing party. These are used for evacuation after the vehicle has been flooded or for firing personal weapons while on the move.

5. Technical Equipment of the Section
Filter Ventilation (NBC): A positive pressure system that protects against chemical, biological and radioactive contamination.
Gun stands: Universal carabiner mounts (e.g. MSBS Grot) with quick release system.
Charging: USB/Inductive sockets at each seat for charging personal radios, night vision goggles and tablets.
Under-ceiling storage: Nets and shelves for light equipment to prevent anything from flying loose when driving over bumpy roads.

6. Internal Security
Spall Liner: The entire interior is lined with ultra-high-density polyethylene (UHMWPE) mats. If the main armor is penetrated, these mats trap a "cloud" of fragments that would otherwise kill everyone inside.
Lighting: LED with "Blackout" function (only red light, not damaging the eye's adaptation to darkness).

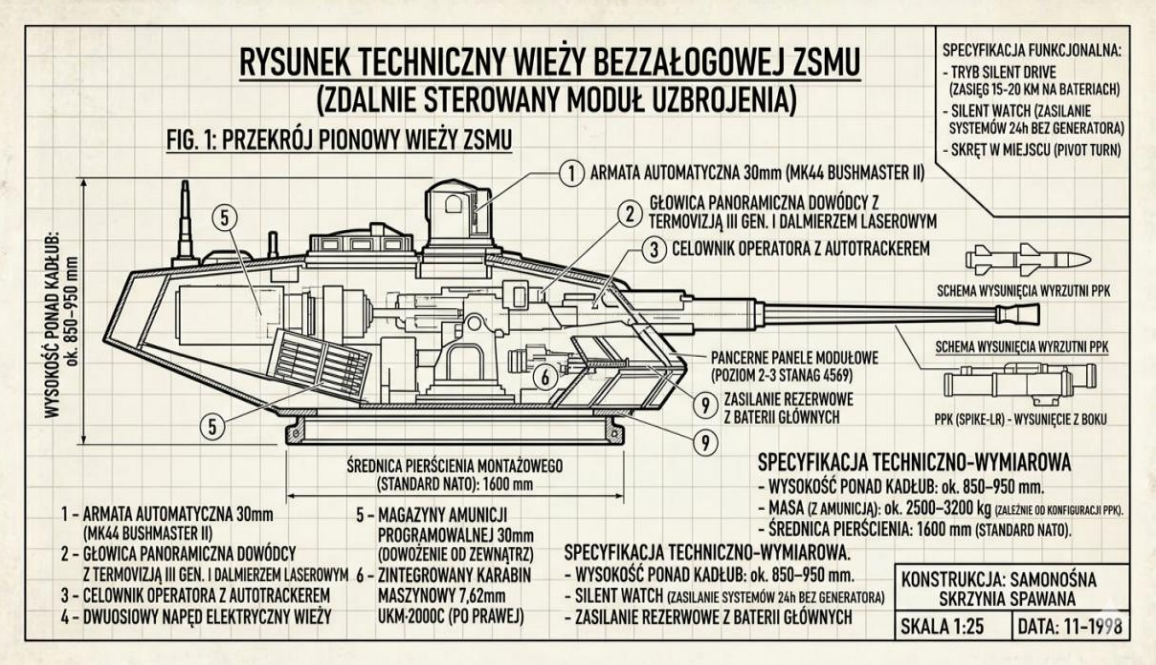
Top Secret

Chapter 7

The unmanned turret of the TOR transporter is a ZSMU (Remotely Controlled Weapons Module) system that does not take up space inside the hull (no turret basket), which ensures full safety of the crew in the event of a hit to the rotation mechanism.

1. Main and Auxiliary Armament
Automatic Cannon: 30 mm (e.g. Mk44 Bushmaster II) with double-sided ammunition feed system.
Rate of fire: 200 rpm (standard mode) or up to 600 rpm.

Programmable Ammunition: Ability to detonate a projectile over a trench or behind an obstacle (crucial in urban and forested areas).
Machine Gun: Coupling 7.62 mm (e.g. UKM-2000C) mounted on the right side of the gun.
ATGM launchers: 2 containers with anti-tank missiles (e.g. Spike-LR) extendable from the side of the turret to engage main battle tanks at ranges up to 4-5 km.


RYSUNEK TECHNICZNY WIEŻY BEZZAŁOGOWEJ ZSMU
(ZDALNIE STEROWANY MODUŁ UZBROJENIA)
FIG. 1: PRZEKRÓJ PIONOWY WIEŻY ZSMU
SPECYFIKACJA FUNKCJONALNA:
- TRYB SILENT DRIVE (ZASIĘG 15-20 KM NA BATERIACH)
- SILENT WATCH (ZASILANIE SYSTEMÓW 24h BEZ GENERATORA)
- SKRĘT W MIEJSCU (PIVOT TURN)
1 ARMATA AUTOMATYCZNA 30mm (MK44 BUSHMASTER II)
2 GŁOWICA PANORAMICZNA DOWÓDCY Z TERMOVIZJĄ III GEN. I DALMIERZEM LASEROWYM
3 CELOWNIK OPERATORA Z AUTOTRACKEREM
SCHEMA WYSUNIĘCIA WYRZUTNI PPK
WYSOKOŚĆ PONAD KADŁUB: ok. 850–950 mm
PANCERNE PANELE MODUŁOWE (POZIOM 2-3 STANAG 4569)
9 ZASILANIE REZERWOWE Z BATERII GŁÓWNYCH
SCHEMA WYSUNIĘCIA WYRZUTNI PPK
PPK (SPIKE-LR) - WYSUNIĘCIE Z BOKU
ŚREDNICA PIERŚCIENIA MONTAŻOWEGO (STANDARD NATO): 1600 mm
SPECYFIKACJA TECHNICZNO-WYMIAROWA
- WYSOKOŚĆ PONAD KADŁUB: ok. 850–950 mm.
- MASA (Z AMUNICJĄ): ok. 2500–3200 kg (ZALEŻNIE OD KONFIGURACJI PPK).
- ŚREDNICA PIERŚCIENIA: 1600 mm (STANDARD NATO).
1 - ARMATA AUTOMATYCZNA 30mm (MK44 BUSHMASTER II)
2 - GŁOWICA PANORAMICZNA DOWÓDCY Z TERMOVIZJĄ III GEN. I DALMIERZEM LASEROWYM
3 - CELOWNIK OPERATORA Z AUTOTRACKEREM
4 - DWUOSIOWY NAPĘD ELEKTRYCZNY WIEŻY
5 - MAGAZYNY AMUNICJI PROGRAMOWALNEJ 30mm (DOWOŻENIE OD ZEWNĄTRZ)
6 - ZINTEGROWANY KARABIN MASZYNOWY 7,62mm UKM-2000C (PO PRAWEJ)
SPECYFIKACJA TECHNICZNO-WYMIAROWA.
- WYSOKOŚĆ PONAD KADŁUB: ok. 850–950 mm.
- SILENT WATCH (ZASILANIE SYSTEMÓW 24h BEZ GENERATORA)
- ZASILANIE REZERWOWE Z BATERII GŁÓWNYCH
KONSTRUKCJA: SAMONOŚNA SKRZYNIA SPAWANA
SKALA 1:25
DATA: 11-1998

2. Sighting Systems and Optics (Polish PCO Standards)
The turret operates in the Hunter-Killer system (Commander detects – Gunner destroys).
Commander's Panoramic Head: Independent 360° observation device with third-generation thermal imaging and laser rangefinder.
Operator Sight: Integrated with the gun axis, with autotracker (automatic target tracking, even when the TOR is moving).
Ammunition capacity: 200–400 rounds of 30 mm and 1000–2000 rounds of 7.62 mm, loaded from the outside under the turret armor.

3. Construction and Drives
Tower Drive: Fully electric (no hydraulics – lower risk of fire).
Elevation Angles: From -10° to +60°. High elevation angle allows for combating drones and shooting at upper floors of buildings.
Stabilization: Two-axis gyroscopic, allowing for accurate firing at off-road speeds of up to 40 km/h.

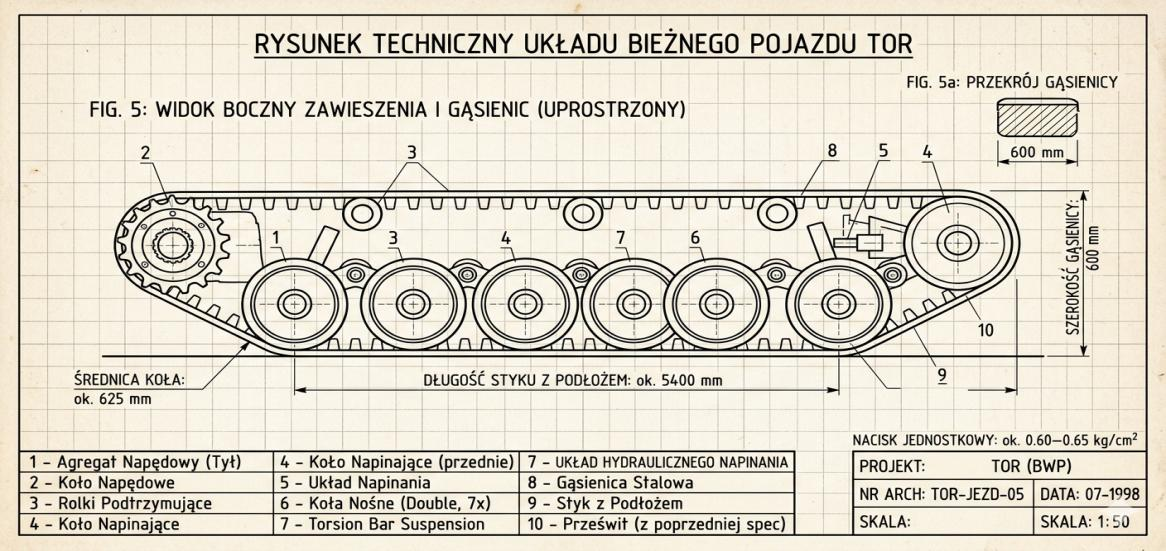
4. Protection and Survivability
Turret Armor: Level 2-3 according to STANAG 4569 (resistance to fragments and 12.7 mm / 14.5 mm bullets).
Warning System: SSP-1 Obra sensors (Polish production) detecting laser radiation and automatically firing smoke grenades at the threat.
Backup Mode: In the event of an electronics failure, the turret has power backup systems from the hull's main batteries.

5. Tower Dimensional Specifications
Height above hull: approx. 850–950 mm.
Weight (with ammunition): approx. 2500–3200 kg (depending on ATGM configuration).
Ring Diameter: 1600 mm (NATO standard).

Chapter 8

The TOR chassis is designed for extreme loads (40 tons+) and the specific conditions of Polish peat bogs and wetlands. The use of seven load-bearing wheels per side is key to stability and low unit pressure.

1. Chassis Specifications (7 road wheels)
The increased number of wheels (standard in IFVs are 6) allows for better weight distribution and a smoother ride in difficult terrain.
Number of support wheels: 14 (7 on each side).
Wheel type: Double, steel with rubber bands (diameter approx. 600–650 mm).
Drive wheel: Rear (optimal for electric drive and protection of the engines from terrain obstacles).
Idler: At the front, with a hydraulic automatic track tensioning system controlled from the driver's cab.
Support rollers: 3-4 per side (prevents the upper branch of the track from sagging).


RYSUNEK TECHNICZNY UKŁADU BIEŻNEGO POJAZDU TOR
FIG. 5: WIDOK BOCZNY ZAWIESZENIA I GĄSIENIC (UPROSTRZONY)
FIG. 5a: PRZEKRÓJ GĄSIENICY
600 mm
SZEROKOŚĆ GĄSIENICY: 600 mm
ŚREDNICA KOŁA: ok. 625 mm
DŁUGOŚĆ STYKU Z PODŁOŻEM: ok. 5400 mm
NACISK JEDNOSTKOWY: ok. 0.60–0.65 kg/cm²
1 - Agregat Napędowy (Tył)
2 - Koło Napędowe
3 - Rolki Podtrzymujące
4 - Koło Napinające
4 - Koło Napinające (przednie)
5 - Układ Napinania
6 - Koła Nośne (Double, 7x)
7 - Torsion Bar Suspension
7 - UKŁAD HYDRAULICZNEGO NAPINANIA
8 - Gąsienica Stalowa
9 - Styk z Podłożem
10 - Prześwit (z poprzedniej spec)
PROJEKT: TOR (BWP)
NR ARCH: TOR-JEZD-05
DATA: 07-1998
SKALA:
SKALA: 1:50

2. Tracks – Dimensions and Material
Designed so that the TOR does not "sink" where other cars stop.
Track width: 600 mm (optional 630 mm for the "Bagno" version).
Length of contact with the ground: approx. 5400 mm.
Unit pressure: approx. 0.60–0.65
(a result similar to light vehicles, despite the high total weight).

Track type: Segmented, steel with replaceable rubber pads (for driving on asphalt) or composite (continuous rubber) – reduces noise by 10 dB and vibrations by 65%, which saves electronics and the crew's backs.

3. Hydropneumatic Suspension
Instead of classic torsion bars, TOR has independent hydropneumatic cylinders for each wheel.
Wheel travel: +/- 350 mm (excellent damping at high speed on bumpy roads).
Clearance adjustment: Possibility of lowering the hull (hiding in an ambush) or raising it (overcoming tree trunks, boulders).
Platform Stabilization: The system actively stiffens the suspension during 30mm cannon firing, eliminating vehicle rocking.

4. Numbers and Terrain Capabilities
Crossing ditches: up to 2.8 m wide.
Vertical walls: up to 0.9 m high.
Approach/departure angle: 35° / 35°.
Wading: up to 1.5 m without preparation (with preparation – full amphibious or bottom driving).

5. Support Structure
Control Arms: Reinforced, forged from high-impact steel.
Mine resistance: The first and last support wheels have reinforced dampers that absorb the energy of an anti-vehicle mine explosion, protecting the rest of the system.

Chapter 9

With this combination – 900 HP from an electric drive on a 7-wheel chassis with hydropneumatic suspension – the TOR becomes one of the fastest and most stable vehicles in its class.

Here are the specific performance figures you'll get from this machine:

1. Dynamics and Speed (900 HP Drive)
Thanks to electric motors, torque (approx. 3,000 Nm) is available from 0 rpm, which gives you an advantage over traditional diesel engines.
Maximum speed (road): 85–90 km/h (electronically limited to protect the tracks).
Off-road speed: 50–60 km/h (stable ride without suspension bottoming out).
Acceleration 0-32 km/h: approx. 5 seconds (crucial when quickly leaving the firing zone).
Gradeability: 60% gradient (31 degrees) – starts uphill without getting out of breath thanks to the electric drive.

2. Hydropneumatic Suspension Performance
This suspension not only dampens vibrations, but actively manages the car's silhouette.

Top Secret

Aiming Stabilization: When firing a 30mm cannon, the suspension stiffens in milliseconds, increasing accuracy by 30% compared to classic torsion bars.
Ground clearance adjustment: Range from 250 mm (hiding the vehicle in an ambush/transport) to 600 mm (overcoming deep ruts and tree trunks).
Landing Comfort: Vibration reduction by 60%, meaning that after a 5-hour ride, soldiers emerge from the vehicle combat-ready, not with motion sickness.

3. Range and Autonomy (Hybrid)
Total range (Diesel + Batteries): approx. 600–800 km (depending on terrain).
Silent Drive Mode (Batteries Only): 15-20 km of complete silence – ideal for stealthy approaches to enemy positions.
Silent Watch: Up to 48 hours of operation of the optoelectronic and air conditioning systems without starting the combustion engine.

4. Operational Mobility
Turning radius: Pivot Turn possible thanks to counter-rotating electric motors.
Unit pressure: Thanks to 7 wheels and a wide track, TOR will drive on ground that would sink a person to the knees (pressure of approx. 0.65 kg/cm²).

5. Resistance of the Chassis System
Driving without a wheel: Thanks to 7 supporting wheels and independent suspension, the TOR can continue driving even after the loss of one or two wheels (e.g. after a mine explosion or shelling).

Top Secret

Chapter 10

The Battle Management System (BMS) for the TOR transporter is a digital network connecting the vehicle with command, drones, and other vehicles in real time. In Polish conditions, it must be fully compatible with the TOPAZ system (WB Group) and NATO standards (Link 16).

Here are the full specifications and operating instructions:

1. System Architecture (Hardware)
BMS in TOR is based on three hardware pillars:
Combat Server: A duplicate computer with high processing power, resistant to shocks and electromagnetic pulses (EMP).
Commander's Terminal: 15-inch high-brightness touchscreen (glove-friendly).
Digital Radio Stations: Broadband radios (e.g. Polish PERAD) that transmit not only voice, but also huge amounts of data (camera images, GPS positions).

2. Operational Functionalities (What the Crew Sees)
BMS changes the way you fight from "looking through the viewfinder" to "managing the battlefield":

Blue Force Tracking (BFT): Automatically plots the positions of all friendly units on a digital map. Eliminates the risk of friendly fire.
Red Force Plotting: When a turret operator acquires a target, their position immediately appears on the maps of all other TOR vehicles in the section.
Digital Fire Order: The TOR commander can send a request for artillery support (e.g. to Krabs or Raks) with a single click on the map, sending precise target coordinates.

3. Crew Service
The system is designed to not distract from the fight:
Commander: Manages target priorities. Can "hand off" a target detected by the BMS directly to the turret operator's targeting system (Slew-to-Cue function).
Driver: Receives a mapped route on his screen (so-called "safe corridor") that avoids detected minefields or danger zones.
Drop: The soldiers in the rear see the image from the TOR reconnaissance drone on their screens, so they know which way to jump off the ramp for cover.

4. Technical Specifications of Communications
Encryption: AES-256 (military standard), dynamically changing keys.
Jamming Resistance (LPI/LPD): The system operates in Frequency Hopping mode, making it difficult for an enemy to detect and jam the signal.
Integration with UAV (Drone): TOR has its own terminal dedicated to the drone (e.g. FlyEye), which after taking off from the roof becomes the "eye" of the BMS within a radius of 30 km.

5. "Black Box" Function
The BMS records every mission parameter, from ammunition consumption and battery power to camera recordings and position history. This allows for post-fight analysis (After Action Review).

6. Autonomy and AI (Decision Support)
The BMS on-board computer has an artificial intelligence module that:
Target Selection: Warns which of the detected objects poses the greatest threat (e.g., an ATGM launcher).
Energy Management: Informs the commander how many kilometers the vehicle can still travel in Silent Drive mode before the generator needs to be turned on.

Top Secret

Chapter 11

The Active Protection System (ASOP) for the TOR transporter is a double-layered shield designed to destroy or confuse incoming projectiles before they reach the main armor. In the age of kamikaze drones (FPVs) and modern ATGMs, this is the most important survival system.

1. Soft-Kill Layer
The first line of defense that makes TOR "elusive" to guidance systems.

Obra-3 System (Poland): A set of sensors around the fuselage that detect laser radiation (from rangefinders or target illuminators).
Smoke Grenade Launchers: 8-12 launchers integrated with the BMS. Upon detecting a laser, the system deploys an impenetrable aerosol smoke cloud in 0.5 seconds that blocks laser, thermal imaging, and visible light.
WRE (Electronic Warfare): "Jumper" Module – emits interference on the radio frequencies used by FPV drones, creating a 50-meter "bubble" of radio silence around the vehicle.

2. Hard-Kill Layer (Physical Destruction)
If a projectile penetrates the smoke, the Hard-Kill system destroys it in flight.
Tracking Radars: Four compact phased array radar antennas (AESA) mounted on the corners of the turret. They track targets flying at speeds between 70 and 1000 m/s.
Explosive Effectors: Anti-missile cassettes located on the sides and turret.
Action: The computer calculates the rendezvous point and fires a counter-missile that explodes 2-3 meters in front of the TOR, destroying the incoming RPG grenade or rocket with a beam of (explosive) fragments.
Response Time: Less than 100 milliseconds.

3. Upper Hemisphere Protection (Anti-Drone)
Key on the Polish front, where the threat is attacks from above (so-called "top-attack").
Dedicated C-UAS Module: A micro-radar is mounted on the unmanned tower to detect small drones.
Energy/Kinetic Grid: Special bar armor (called a cage) over the hatches, which is integrated with the turret structure so as not to restrict its rotation.
Firefighting: A 30mm cannon with programmable ammunition can be automatically directed by the ASOP towards an incoming drone to destroy it with a cloud of tungsten fragments.

4. Specifications and Layout
Power supply: The ASOP is connected directly to the 800V bus of the hybrid drive, which guarantees rapid charging of the launcher capacitors.
Landing Security: The system has "exclusion zones." If sensors detect a landing hatch is open (soldiers exiting), the Hard-Kill system in that sector is deactivated to avoid harming friendly personnel.
Modularity: ASOP cartridges are interchangeable "cubes." After repelling an attack, the crew can replace a worn-out module with a new one in minutes.

5. Integration with BMS
Any ASOP system activation (laser detection or missile destruction) is immediately reported to the command network. Other TOR vehicles in the area can immediately see the origin of the shot on their maps and respond with fire.

Top Secret

Chapter 12

Integrating the TOR with unmanned aerial vehicles transforms it from a transporter into a digital command center. The system relies on its own

onboard reconnaissance drone and the ability to intercept loitering munitions.

1. On-Board Micro-Aircraft Carrier (UAV Docking Station)
On the roof of the hull, behind the unmanned turret, there is a docking station protected by an armored hatch.
Dedicated drone: Vertical-lift (VTOL) aircraft, codenamed "OKO-TOR." Takes off vertically, requiring no runway.
Automation: Take-off and landing are fully automatic, even when the vehicle is in motion (precise radio guidance).
Charging: After landing and closing the hatch, the drone arms are automatically connected to the inductive charging station from the vehicle's main batteries.

2. Specifications of the "OKO-TOR" Drone
Operational range: 20–30 km from the vehicle.
Flight time: 60-90 minutes on a single charge.
Sensors: Optoelectronic head with 30x zoom, thermal imaging and target illuminator for Spike missiles fired from the TOR turret.
Communication: Encrypted data link integrated with the BMS system. The drone image is simultaneously visible to the Commander, Gunner, and Airborne.

3. Combat Functions and Turret Cooperation
Targeting: The drone detects an enemy tank behind a forest. The commander marks the target on the screen, and the 30mm turret automatically rotates toward it (even though the target is hidden from the vehicle's cameras).
Battalion Drone Network: The TOR can serve as a repeater. Signals from other units' reconnaissance drones are picked up by the TOR's powerful antennas and relayed to command when other vehicles are jammed.
Loitering Munition Control: In the landing compartment there is a station for an additional operator who can control Polish kamikaze drones (e.g. Warmate).

4. Counter-Drone System (C-UAS)
Integration works both ways – TOR must also destroy drones.
Jammer: An EW system integrated into antenna masts that "cuts off" enemy FPV drones from their operators within a 500m radius.
Hard-Kill Link: Information about a detected enemy drone from the ASOP radar is sent to the turret computer, which automatically fires a burst from the programmable 30 mm ammunition.

5. Crew Service
VR Goggles: The commander can use augmented reality goggles to see the drone as if it were flying over the vehicle (a "bird's eye" view superimposed on the terrain).
Sentry Mode: The drone can hover 50 meters above the vehicle while stationary, creating a "virtual periscope" that allows it to see threats from behind buildings or trees.

6. Numbers and Data
Number of drones on the vehicle: 2 (one active, one spare in the cassette).

Top Secret

Weight of the flight module: 85 kg (complete with flap mechanism).
Drone speed: up to 80 km/h (allows you to keep up with TOR on the road).

Chapter 13

In the TOR project, signature management isn't just about "painting," but also about actively concealing a 40-ton mass from modern sensors. We focus on three fields: heat (IR), radar (RF), and noise.

1. Thermal Signature (Thermal Stealth)
Thanks to the hybrid drive, the TOR has a huge advantage, but we have to hide the heat of the generator and the friction of the tracks.
Active cooling (E-Cooling): Instead of one large radiator, TOR has distributed heat exchangers with variable blade geometry fans (noise reduction).
Exhaust Mixer: Diesel generator exhaust gases are mixed with cold air inside the armor before being discharged. The exhaust is directed downward into the airflow being pushed up by the tracks (dispersing the heat spot).
Thermal Shielding: Between the hull and the composite armor is an insulating layer (aerogel) that traps heat from the vehicle's interior, keeping the outer armor at ambient temperature.

2. Radar Cross Section (RCS)
Hull Geometry: Armor plates are angled (so-called shaping technology), which reflects radar waves upwards or to the side, rather than back to the enemy transmitter.
RAM Coatings (Radar Absorbent Material): A special polymer paint with ferrites that absorbs radio waves (used on flat surfaces and the tower).
Side Skirts: Heavy ballistic skirts extend almost to the ground, obscuring the spinning road wheels, which are the strongest radar reflectors.

3. Multispectral Camouflage (Mobile)
Application of the Polish Berberys system (Lubawa SA):
3D Cover: Special covers permanently attached to the armor, whose structure resembles leaves/sand.
The result: 80% reduction in radar echoes and 85% reduction in infrared emissions. A vehicle parked in the forest is invisible to satellites and reconnaissance drones with IR cameras.

4. Acoustic Signature (Silent Ride)
Silent Drive: Electric motors generate only a quiet whistling sound. At distances beyond 100 meters at night, the TOR is inaudible in field conditions.
Composite Tracks (CRT): Rubber-composite tracks eliminate metallic link chatter, which is crucial in urban terrain.

5. Ghost Mode Specifications
After pressing one button by the commander, the BMS computer:
Switches the drive to clean batteries.
Closes the radiator shutters (working on the thermal buffer).

Top Secret

Disables all active radars (ASOP goes into passive mode – optics only).
Limits the radio station's transmitting power to the minimum necessary.

Chapter 14

The Soft-Kill system in the TOR transporter is an intelligent electronic-optical shield. Its purpose is to cause an incoming missile to "lose" its target or be unable to launch at all. Unlike Hard-Kill, this system doesn't physically destroy the missile, but rather blinds and deceives its sensors.

1. Detection: SSP-1 OBRA-3 System (Poland)
This is the foundation of self-protection, integrated with the mission computer.
Sensors: 8 heads distributed around the hull and on the turret, covering 360°.
Function: Detects laser beam radiation (from rangefinders, target illuminators for Hellfire/Spike missiles, or beam guidance).
Reaction: In less than 0.2 seconds, the system provides the direction of the threat, the type of laser and automatically turns the turret towards the gunner.

2. Active Countermeasures: Aerosol Grenades
If the TOR is detected, the system automatically (or on the commander's command) sets up a screen:
Launchers: 12 81 mm caliber barrels (6 on each turret side).
Multispectral Aerosol: This isn't just smoke. The cloud contains metallized and graphite particles that:
They block the laser: The guidance beam "blurs" and does not reach the car.
Block Thermal Vision: Creates a wall of ambient temperature behind which the TOR disappears to enemy IR cameras.
Blocks vision: Completely cuts off optical visibility for approximately 60–90 seconds.

3. Optical Blinders (Lazzler)
A modern addition mounted next to the 30mm cannon:
Operation: A powerful laser emitter that, upon detecting enemy optics (e.g. the lens of an ATGM gunner's sight), sends a focused beam of light towards it.
Effect: Momentarily or permanently blinds enemy camera arrays and the operator on the other side of the sight, making precise aiming impossible.

4. Drone Jamming (C-FPV)
Dedicated Soft-Kill module against kamikaze drones:
Omnidirectional Jammer: Generates white noise on 433 MHz, 900 MHz, 2.4 GHz and 5.8 GHz frequencies.
How it works: Creates a "dead zone" with a radius of 150-200 meters around the vehicle. Once the FPV drone enters this zone, it loses video and control, typically by hitting the ground or overflying the target.

5. Decoys

Top Secret

Heat Simulators: There are screens inside the hull that can pulse heat in specific locations to fool simple infrared (IR) guided missiles into thinking the engine is in a different location than it actually is.
Radio Traps: The system can emit false radio signals away from the vehicle to mislead enemy electronic intelligence as to the exact number of vehicles in the group.

6. Service and Integration
The system operates in Auto, Semi-Auto, or Manual modes. In Auto mode, the computer automatically decides to launch the smoke if it determines that the missile's arrival time is critical. All events are plotted on the BMS map, informing other TORs of the enemy firing position.

Chapter 15

The TOR transporter's logistics and autonomy are designed to allow the vehicle to operate independently of main supply lines for at least 72 hours. This leverages the advantages of a hybrid drive and the Polish concept of "distributed service."

1. Energy and Fuel Autonomy
TOR is not just a combat vehicle, it is a mobile power plant.
Operating range: 600–800 km on a full tank (approx. 600 liters of fuel) and charged batteries.
Fuel management: The combustion engine (generator) always operates in the optimal speed range, which reduces fuel consumption by 25-30% compared to classic off-road drives.
E-Logistics: Possibility of fast battery charging (up to 80% in 30 minutes) from stationary civilian networks or field energy containers (Power-Packs).

2. Modularity and Field Repair (Plug & Play)
The design of the hull and drive allows for the replacement of key components in field conditions (LRU standard – Line Replaceable Unit):
Power-Pack: The entire power unit (diesel + generator) is mounted on a single rail. Replacing the entire module using a crane (e.g., from a technical support vehicle) takes less than 60 minutes.
Electric motors: Located in the hubs/final drives, they are easily accessible from the outside after removing the covers.
Armor: Composite panels are bolted together. Damaged panels can be unscrewed and replaced without the need for welding to the hull.

3. Predictive Diagnostics (Health & Usage Monitoring System - HUMS)
The on-board computer not only informs about faults, but also predicts them:
Wear Sensors: Monitor generator oil condition, battery cell temperature, and track voltage.
Automatic reporting: The BMS system sends a message to logistics: "TOR No. 04 needs filter replacement in 10 operating hours and 200 rounds of 30mm ammunition restocked." This ensures that supplies wait for the vehicle, not the other way around.

Top Secret

4. Food and Medical Autonomy (3+8 people)
Resources: Drinking water tank (50 liters) integrated with a filtering system and a food ration refrigerator (SR) hidden in the landing compartment.
Medical Kit: Integrated AED defibrillator and oxygen system connected to each landing station (help in the event of smoke or gas shock).
Power for infantry: 8 NATO-standard charging sockets allow soldiers to charge their radios and night vision devices directly from the vehicle's battery while in transit.

5. Ammunition Logistics
Quick loading: The 30 mm gun feed system allows you to replenish ammunition from the belts without having to enter the turret (safety under fire).
Unification: Use of standard NATO 30x173 mm ammunition, identical to that used in the Rosomak APC or Borsuk IFV, which simplifies the supply chain.

6. Transport and Transfer
Railway: The dimensions of the TOR allow for transport on standard PKP platforms without dismantling the side covers.
Aviation: Can be transported by C-130 Hercules aircraft (after removing the additional armor and turret) or in its entirety by C-17 Globemaster aircraft.

7. Emergency Mode
In the event of a complete fuel shortage, the TOR can fight and move solely on electricity, and the batteries can be recharged by deployable photovoltaic panels (an option for reconnaissance missions) or from any external DC power source.

Chapter 16

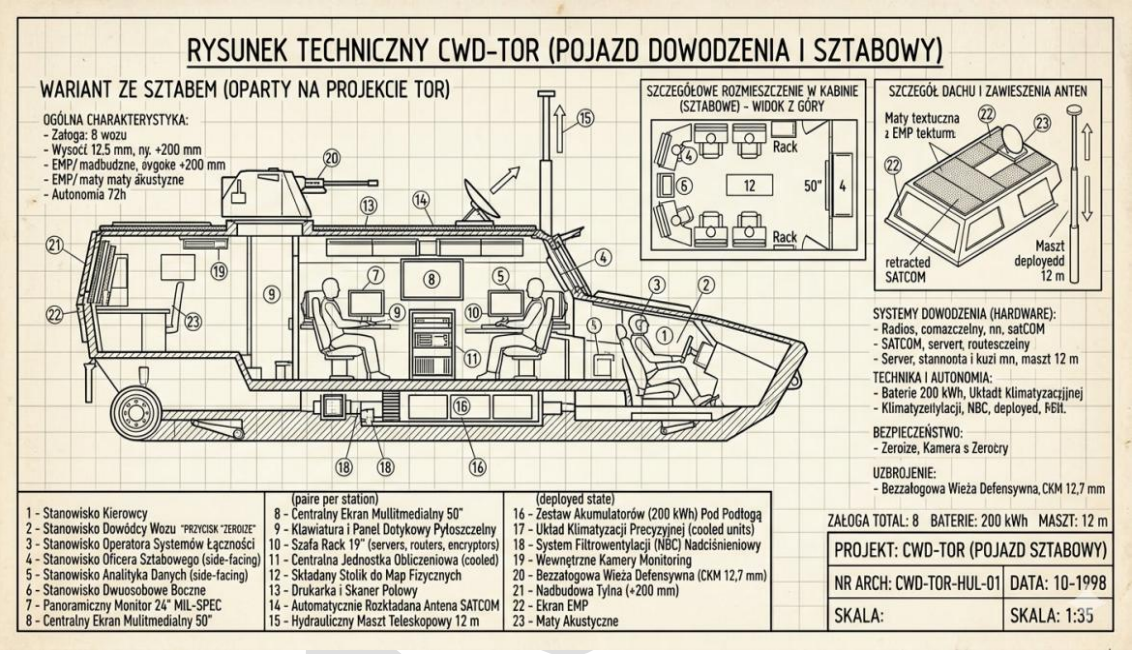
Converting the TOR transporter into a Heavy Command Vehicle (CWD-TOR) requires abandoning the landing section in favor of a mobile headquarters. Thanks to its hybrid drive and massive battery power reserve, it is an ideal platform for powering advanced electronics without betraying position through engine noise.

1. General Characteristics of the Staff Cabin
The rear landing compartment is raised by 200 mm (superstructure) to allow staff officers to work seated at large monitors. The interior is shielded against electromagnetic pulses (EMP) and soundproofed with acoustic mats.
Permanent crew: 3 people (driver, vehicle commander, communication systems operator).
Staff team: 4 operations officers + 1 data analyst.
Total number of people: 8.

2. Layout of Equipment in the Cabin
The interior is divided into functional zones:

Top Secret

Operations Area (Middle-Rear): Two two-person stations on the sides, facing sideways. Each station has:
Two 24-inch widescreen monitors (MIL-SPEC standard).
Dustproof keyboards and touch panels for digital map management.
Multimedia Wall (Front bulkhead of the compartment): Central 50-inch screen displaying a collective image: tactical situation from the TOPAZ/BMS system, images from long-range drones and the status of subordinate units.
Communications Station (Rear-Left): A 19-inch rack integrated with the armor, containing servers, tactical routers, and encryptors.
Planning Zone (Rear-Right): Folding table for working with physical maps and field printer/scanner.


RYSUNEK TECHNICZNY CWD-TOR (POJAZD DOWODZENIA I SZTABOWY)
WARIANT ZE SZTABEM (OPARTY NA PROJEKCIE TOR)
OGÓLNA CHARAKTERYSTYKA:
- Załoga: 8 wozu
- Wysoćć 12.5 mm, ny. +200 mm
- EMP/ madbudzne, ávgoke +200 mm
- EMP/ maty maty akustyzne
- Autonomia 72h
SZCZEGÓŁOWE ROZMIESZCZENIE W KABINIE (SZTABOWE) - WIDOK Z GÓRY
Rack
12
50"
4
Rack
SZCZEGÓŁ DACHU I ZAWIESZENIA ANTEN
Maty textuczna z EMP tekturm
retracted SATCOM
Maszt deployedd 12 m
SYSTEMY DOWODZENIA (HARDWARE):
- Radios, comazczelny, nn, satCOM
- SATCOM, servert, routesczelny
- Server, stannoota i kuzi mn, maszt 12 m
TECHNIKA I AUTONOMIA:
- Baterie 200 kWh, Układt klimatyzacjjnej
- Klimatyzetlylacji, NBC, deployed, Fétt.
BEZPIECZEŃSTWO:
- Zeroize, Kamera s Zerocry
UZBROJENIE:
- Bezzałogowa Wieża Defensywna, CKM 12,7 mm
1 - Stanowisko Kierowcy
2 - Stanowisko Dowódcy Wozu "PRZYCISK "ZEROIZE"
3 - Stanowisko Operatora Systemów Łączności
4 - Stanowisko Oficera Sztabowego (side-facing)
5 - Stanowisko Analityka Danych (side-facing)
6 - Stanowisko Dwuosobowe Boczne
7 - Panoramiczny Monitor 24" MIL-SPEC
8 - Centralny Ekran Mulitmedialny 50"
(paire per station)
8 - Centralny Ekran Mullitmedialny 50"
9 - Klawiatura i Panel Dotykowy Pyłoszczelny
10 - Szafa Rack 19" (servers, routers, encryptors)
11 - Centralna Jednostka Obliczeniowa (cooled)
12 - Składany Stolik do Map Fizycznych
13 - Drukarka i Skaner Polowy
14 - Automatycznie Rozkładana Antena SATCOM
15 - Hydrauliczny Maszt Teleskopowy 12 m
(deployed state)
16 - Zestaw Akumulatorów (200 kWh) Pod Podłogą
17 - Układ Klimatyzacji Precyzyjnej (cooled units)
18 - System Filtrowentylacji (NBC) Nadciśnieniowy
19 - Wewnętrzne Kamery Monitoring
20 - Bezzałogowa Wieża Defensywna (CKM 12,7 mm)
21 - Nadbudowa Tylna (+200 mm)
22 - Ekran EMP
23 - Maty Akustyczne
ZAŁOGA TOTAL: 8 BATERIE: 200 kWh MASZT: 12 m
PROJEKT: CWD-TOR (POJAZD SZTABOWY)
NR ARCH: CWD-TOR-HUL-01
DATA: 10-1998
SKALA:
SKALA: 1:35

3. Hardware and Command Systems
Radio stations: Set of 4 wideband radio stations (VHF/UHF/HF) operating in the frequency hopping system.
Satellite Communications (SATCOM): An automatically deployable antenna on the roof, enabling communication with strategic command while on the move.
Server Room: A liquid-cooled central processing unit that maintains databases of enemy potential and friendly supplies.
Antenna Mast: Telescopic mast (height up to 12 m) hydraulically extendable when stationary, increasing the range of local radio stations.

4. Technical Specifications and Autonomy
Guaranteed Power: Thanks to its 200 kWh batteries, the CWD-TOR can operate at full power for 72 hours without turning on the diesel generator (complete silence and no thermal footprint).
Precision air conditioning: A system with increased efficiency, cooling not only people, but above all servers (separate circuits).
Filter Ventilation System (NBC): Creates positive pressure in the cabin, allowing staff members to work without masks in the contaminated zone.

5. Data Security
Emergency Destruction: A "Zeroize" button on the commander's panel that physically destroys data carriers if the vehicle is at risk of being captured by the enemy.
Internal Monitoring: Cameras recording the work of the headquarters (post-mission analysis).

6. Defensive Weapons
The CWD-TOR retains the unmanned turret, but with a smaller fire unit (prioritizing space for electronics). Instead of a 30mm cannon, a 12.7mm heavy machine gun with an advanced observation head is often used for self-protection.

Chapter 17

The CBRN-TOR system is an integrated set of sensors located outside the hull, which analyzes air quality and radiation levels in real time, protecting 11 people (3 crew + 8 landing/staff) from invisible threats.

1. Module Layout and Construction
The system is not a single box, but a distributed network of sensors:
Detection Head (Roof): Located at the highest point of the hull (behind the turret) to avoid contamination from kicked-up mud. Contains an air spectral analyzer.
Radiometric Probes (Front and Rear): Two independent Geiger-Müller counters with a wide range (from natural background to nuclear explosion radiation).
External Sampler: A robotic arm that can collect a soil or liquid sample into an airtight container without the crew having to open hatches.

2. Sensor Technical Specifications
Chemical Detection (TIC/CWA): Detects chemical warfare agents (sarin, VX, mustard gas) and toxic industrial substances (chlorine, ammonia). Response time: less than 10 seconds.
Radiological Detection (Gamma/Neutron): Measurement of dose rate and cumulative dose. Automatic warning when approaching a contaminated zone.
Biological Detection (Bio-Trigger): A laser-based airborne particulate analyzer that alerts you to unusual concentrations of aerosols that may contain pathogens.

3. Integration with TOR Systems
This is where the "magic" of a modern car happens:
Automatic Encapsulation: When contamination is detected, the on-board computer closes all ventilation valves in 0.5 seconds and activates filter ventilation in positive pressure mode (outside air passes through carbon and HEPA filters).
BMS Alarm: The system immediately sends a digital warning to the command network: "TOR-01 detected chemical contamination, coordinates X, Y, type: VX." A red prohibited zone appears on the maps of all nearby units.
Survival Counter: The computer calculates how long the crew can safely remain in a contaminated zone based on filter usage.

Top Secret

4. Local Disinfection System
Fluid Dispensers: Nozzles integrated into the hull that can spray disinfectant onto key components (visors, door handles, ramp) to allow for safe exit of the vehicle upon exiting the zone.

5. Operation and Reading (HMI)
Control Panel: Dedicated tab on the commander screen. Green icon for "Clear", Yellow for "Threat", Red for "Contamination - Mask!"
External Alarm: Light and sound alarm on the armor for soldiers outside the vehicle.
Numerical Data:
Power supply: 24V (from low voltage bus).
Total module weight: 12 kg.
Filter operating time: up to 24 hours in full contamination mode (replaceable inserts from inside the vehicle).

Chapter 18

The AI-TOR system is a digital advisor to the commander that processes thousands of sensor data points that the human eye cannot capture in the stress of combat. It doesn't replace humans, but it drastically shortens decision-making time (OODA Loop).

1. Architecture and Processing (Edge Computing)
The system runs locally on the vehicle's servers (no connection to the cloud required, which protects against interference).
NPU (Neural Processing Unit): A processor dedicated to neural networks, integrated with the main BMS computer.
Data Fusion: AI simultaneously analyzes images from 360° cameras, the "OKO-TOR" drone, radio monitoring and terrain data from digital maps.

2. Key Supporting Features
Automatic Target Detection and Classification (ATR): The AI scans the horizon and highlights in red objects matching an enemy's signature (e.g., a gun barrel sticking out of bushes, an antenna, engine heat). It classifies the target as "T-72, range 2100m, high threat."
Terrain Analysis (Pathfinding): Based on maps and drone data, the AI determines the "least risk" route, avoiding places where the enemy statistically most often sets ambushes (ravines, forest edges).
Virtual Periscope: If the drone detects an enemy behind a hill, the AI projects its silhouette as a "ghost" on the crew's monitors, allowing it to see through terrain obstacles.

3. Prediction Module (Movement Prediction)
Behavioral Algorithms: By analyzing the movement of detected enemy units, the system suggests a probable scenario: "3 units detected in dispersion - probable flanking maneuver from the left side."

Top Secret

Energy and Ammo Management: The AI calculates whether your current driving pace will have enough battery power to return to Silent Drive mode and suggests the optimal time to activate the generator to avoid making noise near the enemy.

4. Voice and Visual Interface (HMI)
Priority Alerts: Instead of hundreds of notifications, the AI delivers only the critical ones over the intercom: "Attention, laser targeting, 10 o'clock, smoke suggested."
Augmented Reality (AR): Graphic overlays appear on the commander's screens showing the effective range of your own weapons and dead zones where the vehicle is invisible to the enemy.

5. Safety and Ethics (Human-in-the-loop)
No Fire Autonomy: The AI never fires on its own. It can only guide the turret to the target and prepare firing parameters, but the final trigger pull rests with the operator.
Deep Learning Mode: TOR learns from each mission, memorizing new signatures of enemy equipment encountered on the Polish front.
Technical Data:
Image frame analysis time: 15 ms.
Number of simultaneously tracked objects: up to 200.
AI RAM: 64 GB RAM (LPDDR5).

Chapter 19

The engineering module transforms the TOR into a battering ram capable of clearing a path through urban or forested terrain. Thanks to its electric drive, the winch delivers powerful, constant torque that won't be hampered by mud.

1. Paving Blade (Light Plow Blade)
Designed for removing obstacles, not for heavy earthworks (weight saving).
Construction: Made of high-yield steel (e.g., Armox). Mounted to the front armor using hydraulic quick-release couplers.
Controls: Fully hydraulic (up/down, angle of attack) from the driver's panel.
Features:
Pushing vehicle wrecks up to 20 tons.
Removal of barricades, fallen trees and debris.
Creating simple shelters for the wagon (underground) in soft ground.
Dimensions: Width 3500 mm (slightly wider than the tracks to clear the path for the undercarriage).

2. Electric Winch (Heavy-Duty)
Integrated directly into the main 800V power rail.
Pulling force: 25 tons (up to 50 tons with a pulley block). Allows you to pull your own vehicle or another TOR out of deep mud.

Top Secret

Location: Mounted inside the front part of the hull (under the armor), with the cable leading out through the armored grommet.
Rope: Synthetic (Dyneema), 60 m long – lighter and safer than steel, does not break suddenly.
Hybrid Advantage: The winch can operate with the combustion engine turned off, drawing power from the battery, which allows for silent self-evacuation at night.

3. Anchorage System (Spade System)
To enable the winch to operate at full power without moving the 40-ton truck:
Operation: The blade can be driven vertically into the ground, serving as a powerful anchor (reinforcement blade).
Stability: The hydropneumatic suspension system then locks the support wheels, creating a rigid platform.

4. External Hydraulic Tools (Power Take-Off)
The TOR has hydraulic sockets on the front armor:
Application: Possibility of connecting external tools (hydraulic shears for cutting wrecks, demolition hammers) powered by the vehicle pump.
For whom: Crucial for landing or rescue teams operating from the command vehicle.
Technical Data:
Weight of the blade module: 1200 kg (removable for air transport).
Rope retraction speed: Adjustable from 0.1 to 2 m/s.
Power supply: High pressure hydraulics (320 bar) + Electric winch motor (60 kW).

Chapter 20

The TOR Anti-Tamper System is a vehicle's digital and physical "nervous system" that protects it from sabotage, technology theft, or enemy takeover when the crew is sleeping, resting, or operating outside the vehicle.

1. Perimeter Access Control (Sentry Mode)
The system uses a set of sensors integrated into the fuselage, operating in low-power mode.
Proximity Sensors (Ultrasonic and Radar): Detect movement within a 15-meter radius of the vehicle. The system can distinguish between animals and humans (AI analysis of movement size and pattern).
360° Cameras (Low-Light Mode): Automatically record every approach to the vehicle. Images are immediately transmitted to crew tablets or to the command center via BMS.
Directional Microphones: Detects the sound of armor tampering, drilling attempts, or explosives (magnetization).

2. Active Denial of Access (Non-Lethal Defense)
If the intruder ignores the audio warning (message from external speakers), TOR goes into defense mode:

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"Electric Skin" System: Possibility of applying a high-voltage but low-intensity electric pulse to external handrails and door handles (effectively deters without killing).
Pepper/Tear Gas Launchers: Hidden nozzles in armor niches spray a cloud of gas around the vehicle, preventing tampering with hatches.
Strobe Blinders: Powerful IR/Visible LEDs blind intruders and disrupt civilian night vision devices.

3. System and Data Protection (Cyber-Shield)
This is the most important part of protecting a command vehicle full of classified data.
Biometric Authorization: Activation of combat systems and driving are only possible after facial/fingerprint recognition of an authorized crew member.
"Zeroize" Button (Data Destruction): In the event of a certain takeover of the vehicle, the commander activates a procedure for clearing the operational memory and physically destroying the cryptographic keys (thermal burning of security modules).
Drive Lock: Electric motors are locked by software – the vehicle cannot be towed without disconnecting the transmission, which takes hours.

4. "Black Box" and Alarms
GPS/Galileo location: Even when the main systems are turned off, a hidden transmitter with its own battery sends a signal about the vehicle's position via satellite (emergency frequencies).
"Fratricidal" Alarm: If the system detects an attempt to open the hatch from the outside without entering the code (even by a person in a Polish uniform), it immediately notifies the BMS of a "potential infiltration".

5. Technical Specifications:
Power supply: Independent buffer battery (operation up to 7 days without charging).
Integration: Connected to ASOP system (can use ASOP radars to detect intruders).
"Silent Alarm" Mode: The crew receives a vibration on their watches/tablets without generating any external sound, which allows them to surprise saboteurs.

Top Secret

Chapter 21

The V2L (Vehicle-to-Load) system turns the TOR transporter into a mobile energy hub. Using a powerful 200 kWh energy bank and a hybrid generator, the vehicle can power entire field bases, hospitals, or other vehicles without the need to tow trailers with generators.

1. Connection Panel (Energy Hub)
Located at the rear of the hull, next to the landing ramp, protected by an armored, sealed hatch:
Industrial Sockets (400V / 32A): One three-phase (power) socket for powering heavy engineering equipment, container server rooms or radar systems.
Standard Sockets (230V / 16A): Four sealed sockets for electronics, camp lighting and hand tools.

DC Fast Charging (CCS2): A bi-directional connector that allows charging of unmanned ground vehicles (UGVs) or other electric vehicles directly from the TOR battery.

2. Operational Capabilities (Autonomy)
Thanks to intelligent energy management, TOR offers:
Silent Power: Operates solely on batteries (no exhaust fumes or noise) for approximately 24-48 hours while powering a medium-sized command post.
Continuous Power (Generator Mode): Engaging the diesel generator allows for continuous operation (70 kW net output) as long as there is fuel in the tank.
Energy Buffering: The system can accept electricity from external sources (e.g., the civil grid or photovoltaic panels) and store it in its batteries.

3. Infantry Power (Soldier-Centric)
In addition to the external panel, the system powers internal points:
Inductive Chargers: In the landing compartment, built into the weapon holders and seats (recharges radios and goggles while driving).
DC bus (24V): For direct connection of life support systems or specialized medical equipment.

4. Intelligent Management (Smart Grid)
The TOR on-board computer monitors priorities:
Combat Reserve: The system will automatically cut off external power consumers if the battery charge level drops to 25% (guaranteed energy for quiet departure from position).
Overload Protection: Automatic fuses protecting the vehicle's installation against short circuits in connected external equipment.

5. Technical Specifications:
Output power (peak): up to 100 kW.
Output power (continuous): 60-70 kW.
Inverter efficiency: 97% (minimal heat loss).
Protection: IP67 class (can work in rain and mud).

Chapter 22

The Acoustic Deception System (AD-TOR) is the final piece of the puzzle, using the silence of electric propulsion as a weapon. This system allows the TOR to achieve complete acoustic disappearance or—more importantly—to conduct psychological warfare and disinformation.

1. Active Noise Reduction (Silent Drive+)
Although the electric motors are quiet, the tracks and running gear generate a characteristic hum.
Counter-Phase Emission: Special transducers mounted on the support wheels generate a reverse-phase sound wave that cancels out the metallic sounds of the chassis.

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Vibro-Acoustic Isolation: The engine-generator (diesel) is suspended on magnetic cushions that absorb vibrations before they are transferred to the armor (the hull does not act as a resonance box).

2. Acoustic Projector
A set of high-power directional loudspeakers (LRAD standard), resistant to fire and weather conditions, integrated into the tower.
Column Simulation: The system can emit the recorded sound of heavy tanks (e.g., Abrams or Leopard) in a direction different from the TOR's movement. At night, the enemy hears an armored fist approaching 2 km to the left, while the TOR silently approaches from the right.
Environmental Sounds: Ability to emit civilian sounds (e.g. tractors, trucks), allowing the command vehicle to "get lost" in the noise of urban areas.

3. Psychological Disinformation
Broadcasting Messages: Ability to broadcast voice messages at a distance of up to 1.5 km (e.g. calls to surrender or disinformation in the enemy's language).
Acoustic Paralysis: In defense mode, the system generates very high frequency sounds (infrasound/ultrasound) that cause nausea and disorientation in intruders, preventing them from approaching the vehicle.

4. Ghost Step Mode
The on-board computer analyzes the surroundings (wind, precipitation, terrain) and suggests a driving speed at which the noise of the tracks will be completely masked by the natural sound background.

5. Technical Specifications:
Number of emitters: 4 (front, rear, sides of the tower).
Peak power: 150 dB (in warning mode).
Frequency range: 10 Hz to 25 kHz.
Power: Direct from main battery (low consumption in camouflage mode).
TOR Project Summary
We have built a complete specification of a Polish heavy transporter/command vehicle:
Chassis: 7 wheels, 900 HP hybrid, 200 kWh battery.
Protection: Modular Armor, ASOP Hard/Soft-Kill, Anti-Tamper, Stealth.
Brain: BMS, AI Tactical Advisor, integrated UAV drones.
Versatility: V2L (energy), CBRN (contamination), Engineering Module.

Top Secret

Chapter 23

Here's the complete technical and economic specification sheet for the TOR heavy tracked transporter. The design combines Polish engineering (optics, armor, BMS) with a modern hybrid drive.

1. TECHNICAL DATA SHEET (FINAL SPEC)
Category Parameter Value / Details

Dimensions Length / Width / Height 7.85 m / 3.48 m / 2.40 m (hull)
Weight Combat weight (standard) 38,500 kg (38.5 t)
Crew System 3 + 8 3 (permanent) + 8 (landing or headquarters)
Serial Hybrid 800V drive 2 x electric motors (total power 900 HP)
Diesel Generator Range Extender V6 Turbo 600 HP (Scania/MTU)
Batteries Capacity / Type 200 kWh / LiFePO4 (safe breakdown)
Chassis 7-wheel chassis, hydropneumatic suspension
Track width / pressure 630 mm / 0.65 kg/cm²
Max Speed (road) / Terrain / Silent 90 km/h / 60 km/h / 20 km/h
Range Hybrid / EV Only 750 km / 18–22 km
Armament Unmanned turret 30 mm Bushmaster II + 7.62 mm + 2x ATGM Spike

2. FINISH AND PROTECTION (NUMBERS)
Basic armor: HHS Steel + Ceramics (STANAG 4569 Level 5 - front, Level 4 - sides).
ASOP Hard-Kill: Reaction time < 100 ms, 90% effectiveness against RPG/ATGM.
CBRN: Filter ventilation 250 m³/h, overpressure 300 Pa.
V2L (External Energy): Output 70 kW continuous, 100 kW peak.

RYSUNEK KONCEPCYJNY BWP-90 (WERSJA UPROSZCZONA)
FIG. 1: PRZEKRÓJ PODŁUŻNY
FIG. 2: RZUT Z GÓRY (BEZ WIEŻY)
HYBRID BATTERIA
UKŁAD 4×4, TWARZAMI DO SIERIE
1 - SILNIK-GENERATOR
2 - STANOWISKO KIEROWCY
3 - PIERŚCIEŃ MONT. ZSMU
4 - PRZEDZIAŁ DESANTU
5 - DŁUGOŚĆ KRII PODŁUŻNY
6 - WŁAZY 4×4 (Z PANCERZA DOD.)
7 - HYBRID BATTERIES
8 - WŁAZY DACHOWE DESANTU
9 - RAMPA TYLNA
SKALA 1:75

3. PROTOTYPE PRODUCTION COST ESTIMATION (ESTIMATION)
Building the first, fully functional prototype (TOR-P1) is more expensive than subsequent serial production due to R&D costs, molds and AI software integration.
Project Element Cost (USD) Cost (PLN - approx.) Notes
Chassis and Hull $2,500,000 PLN 10,000,000 Armored steel, machining, suspension
Hybrid Drive $1,200,000 PLN 4,800,000 Motors, batteries, inverters, generator
Unmanned Turret $2,800,000 PLN 11,200,000 Gun, PCO optics, stabilization systems
Electronics and AI $1,500,000 PLN 6,000,000 BMS, sensors, servers, software
ASOP and Stealth Systems $1,000,000 PLN 4,000,000 Radars, Launchers, RAM Shells
Integration and Testing $1,000,000 PLN 4,000,000 Field tests, certification
TOTAL (Prototype) $10,000,000 ~40,000,000 PLN Cost of 1 copy

In case of mass production (over 50 pieces), the unit cost will drop to approximately $6.5 - 7.5 million (PLN 26-30 million).

4. POTENTIAL ANALYSIS (WHY TOR?)
Tactical Advantage: With Silent Drive and Silent Watch modes, the TOR can take position and command without being detected thermally or acoustically.
Unification: The use of Polish components (PCO, WB Group, HSW) facilitates logistics within the country.
Future: The 800V architecture allows for easy implementation of energy weapons (e.g., anti-drone lasers) in the future.

Chapter 24

Building a TOR prototype in Poland is a challenge at the intersection of 1980s armored technology and modern electronics. We have enormous potential, but also specific bottlenecks.
Here is an analysis of the facts, myths and real possibilities of implementing the project on the Polish technology market:

1. Facts (What we can do right now)
Armor and Hull: Huta Stalowa Wola (HSW) has the machinery (robot welding, plasma cutting) capable of fabricating the TOR's hull. ARMSTAL-grade armor steel is manufactured in Poland.
Tower Systems and Optics: PCO SA produces world-class thermal imaging cameras and observation systems, and ZSMUs (Remotely Controlled Weapon Modules) are already mass-produced in Tarnów.
Electronics and Communications: The WB Electronics Group has digital systems (Topaz BMS, radios) that surpass many Western solutions. Integration of AI and drones is within their reach.

2. Myths (Where we need to be careful)
Myth: "Poland will build 450 hp electric motors on its own" – False. Currently, we don't have mass-produced electric motors with such power density and military specifications. A prototype would have to rely on imported components (e.g., from Curtis-Wright or Parker Hannifin).
Myth: "Battery cells are Polish" – False. Although we have large battery factories (e.g., LG near Wrocław), these are civilian cells. We would have to buy specialized LTO cells (resistant to frost and punctures) abroad (USA/Korea) and just package them domestically.
Myth: "Hybrids are cheaper" – False. The hybrid prototype will be approximately 30-40% more expensive than a classic diesel due to complex inverters and power electronics cooling systems.

3. Technological opportunities and barriers

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Possibility – Hybrid Drive: We have great engineers at the Institute of Drives and Electrical Machines (KOMEL) who could design the control and integration of the motors with the tracks.
Barrier – Gears: Manufacturing gears and side gears that can withstand a torque of 3,000 Nm from an electric motor requires very precise production lines, which in Poland are backed up with orders for years.
Possibility – ASOP and Stealth: The Military University of Technology (WAT) is conducting advanced research on radar-absorbing materials (RAM). Implementing these coatings on a prototype is 100% feasible in Poland.

4. Prototype Strategy (Fast Track)
To build TOR in 24 months, a strategic assembly model should be adopted:
Structure: HSW (Hull) + ROSOMAK SA (Suspension).
Drive: Imported components (USA/Israel) + Polish control software (KOMEL/WB).
Combat Systems: WB Group (BMS) + PCO (Optics) + Tarnów (Turret).
Final Assembly: Wojskowe Zakłady Motoryzacyjne (WZM Poznań) – experienced in servicing heavy vehicles (Leopard).

5. Verdict: Will it work?
Poland has 90% of the technology needed to “dress” the vehicle (armor, turret, electronics), but we are missing 10% of the foundation (specialized cells and high-power engines).

Chapter 25

To acquire the missing 10% of technology (high-power propulsion and military-grade cells) and strengthen the CBRN system, we must employ a "technological leap" strategy. Instead of copying the West, we must leverage Poland's specific characteristics and niche advantages.

1. How to get the missing 10% (Motors and Batteries)?
To overcome the barrier of not having our own 450 HP motors and LTO cells, I propose three paths:
Polonization of Technology (Offset): Instead of purchasing pre-built engines from companies like Parker Hannifin or Danfoss, we're forcing technology transfer when purchasing other systems (e.g., for the Korean K2 or Abrams programs). We're establishing a joint venture (e.g., with Poland's KOMEL) to assemble the engines domestically.
Adapted from Civilian Mega-Projects: Poland is a powerhouse in electric bus production (Solaris). Their engines have around 220-250 hp. The idea: Using a multi-motor system (two motors per track, combined in a gearbox). This provides redundancy – if one motor fails, the other continues to turn the track.
LTO batteries "Made in Poland": Collaboration with the Polish branch of Impact Clean Power Technology. They are capable of building battery packs for heavy-duty transport. We need to commission them to "militarize" the housings (vibration and EMP resistance).

2. CBRN 2.0 – Ideas for TOR's "Smart Nose"

Top Secret

The contamination detection system must be autonomous. Here's how to tweak it for Polish conditions:
Contamination Reconnaissance Drone (UAV-CBRN): A small drone (launched from the TOR's roof) equipped with a micro-chemical sensor. Before the vehicle enters a valley or city, the drone flies 500 meters ahead, checking for air purity. This is visualized by the TOR crew as a safe corridor on the BMS.
Passive Remote Detection (Standoff Detection): Installing a spectral detector (lidar/infrared) that "sees" the gas cloud from 2-5 km away. We don't have to drive into the contamination to know it's there.
Intelligent Self-Disinfecting Coating: Using nanotechnology (e.g. titanium dioxide)) in the armor paint. When exposed to UV light (sunlight), this coating accelerates the decomposition of certain chemicals.
Integrated "Survival Counter" in AI: The AI Tactical Advisor system calculates the radiation dose received by each crew member (individual dosimeters connected to the vehicle's Bluetooth) and alerts: "Commander, in 15 minutes you will reach the safe dose limit, I suggest retreat."

3. Actual feasibility (Status 110%)
With this 100% base and an additional 10% of innovation, TOR becomes a unique machine in the world:
Foundation: Polish hull (HSW), Polish optics (PCO), Polish BMS (WB Group).
Engine: Hybrid based on Polish component integration (Joint Venture).
Innovation: CBRN reconnaissance beyond NATO standards (drones and remote sensing).

Chapter 26

The-Shelf) technology. Poland is a hub for the production of electric buses (Solaris, Volvo, MAN) and their components. Incorporating this "civilian DNA" into the TOR transporter is the fastest route to mass production.

Here's how to specifically "militarize" civilian components to survive on the battlefield:

1. Electric Motors (Bus Standard vs. TOR)
Poland produces thousands of bus engines (e.g. in the Tamel and Impact factories).
Adaptation: Instead of one large engine, we use a two-engine system for each track (totalling 4 engines of approximately 225 HP each).
Reinforcement: Civilian engines are air-cooled. In TOR, we enclose them in sealed housings with a water jacket. This allows the engine to operate completely submerged in mud or water (IP69K standard), and the heat is transferred to armored radiators on top of the hull.

2. Inverters and Power Electronics (Tram Standard)
Medcom Poland is a world leader in rail traction inverters. Their devices operate 24/7 in challenging conditions.

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Adaptation: We take the power modules from trams, but change their housing to milled aluminum (shock resistance).
EMP Protection: We cover civilian electronics circuit boards with a thick layer of conformal varnish and resin, and shield the entire control cabinet with a copper mesh to prevent an electromagnetic pulse (nuclear explosion/microwave weapon) from burning out the transistors.

3. Baterie (Standard LG Energy Solution / Impact)
Poland is the largest exporter of batteries in the EU. Cells from passenger cars are cheap and energy-dense.
Adaptation: Instead of one large "battery," we build a honeycomb structure. Each cell is housed in a separate chamber filled with a non-flammable gel.
Safety: If shrapnel penetrates one section, the system cuts it off pyrotechnically (explosive fuse), while the remaining 90% of the battery continues to power the vehicle. We equip civilian BMSs (management systems) with Polish encryption algorithms.

4. Advantages of the "Civil Heart" in TOR:
Logistics: Spare parts (bearings, seals, hall sensors) are available in every civilian warehouse in Poland.
Reliability: Bus components are designed for a million kilometers of mileage. In the military, where a vehicle covers 2,000-3,000 km per year, such a drive is practically "immortal."
Cost: By using the civilian engine production line, we reduce the drive cost by 60% compared to dedicated military solutions from the USA.

5. Risk and Solution (Bottleneck)
Civilian components are not resistant to high-frequency vibrations (track chatter).
Solution: The entire drive unit (engines + inverters) is mounted on active vibration isolators (magnetic cushions) that isolate the delicate electronics from hull vibrations.
Summary: We're building the TOR as an "armored electric bus on steroids." This allows us to build a prototype in 12-18 months, instead of 10 years of research.

Chapter 27

Here is the complete, final cost estimate of the TOR project (Heavy Tracked Transporter – Prototype), prepared in accordance with your assumption of using the Polish civilian potential (COTS) and reducing unit costs by 40-50% compared to classic, purely military systems.

TOR PROJECT COST ESTIMATE (P1 PROTOTYPE
Estimated values in PLN (Net)
System Category Cost (PLN million) Polish Share / Origin Technological Notes
1. Hull and Structure (HSW) 9.5 100% Polish Steel ARMSTAL, robotic welding.
2. Electric Drive (Militarized) 6.0 70% Poland (Impact/KOMEL) Civilian engines (adapted), SiC modules (import).

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3. Energy Storage (200kWh Batteries) 4.5 60% Poland (Impact) Imported cells (LTO), housing and BMS (Poland).
4. Generator (Range Extender) 3.0 40% Poland (Andoria/Import) V6 engine (Diesel) + Polish high power alternator.
5. Unmanned Turret (ZSMU) 14.0 80% Poland (ZMT/PCO) Polish optics and controls, gun (license).
6. Electronics, AI and BMS (WB Group) 8.0 95% Poland TOPAZ system, AI Advisor, PERAD connectivity.
7. Protection Systems (ASOP/Obra) 7.5 50% Poland (PCO/Import) Polish detection (Obra), Hard-Kill (partnership).
8. Suspension and Chassis 4.5 100% Polish Hydropneumatics (dedicated project).
9. Special Modules (CBRN/V2L/Dron) 3.5 90% Poland FlyEye drone (WB), Polish chemical sensors.
10. Integration and Field Testing 5.0 100% Poland Type testing, ballistic and traction tests.

RYSUNEK TECHNICZNY CWD-TOR (POJAZD DOWODZENIA I SZTABOWY)
WARIANT ZE SZTABEM (OPARTY NA PROJEKCIE TOR)
OGÓLNA CHARAKTERYSTYKA:
- Załoga: 8 wozu
- Wysoćć 12.5 mm, ny. +200 mm
- EMP/ madbudzne, avgoke +200 mm
- EMP/ maty maty akustyzne
- Autonomia 72h
SZCZEGÓŁOWE ROZMIESZCZENIE W KABINIE (SZTABOWE) - WIDOK Z GÓRY
Rack
12
50"
4
Rack
SZCZEGÓŁ DACHU I ZAWIESZENIA ANTEN
Maty textuczna z EMP tekturm
retracted SATCOM
Maszt deployedd 12 m
SYSTEMY DOWODZENIA (HARDWARE):
- Radios, comazczelny, nn, satCOM
- SATCOM, servert, routesczeiny
- Server, stannoota i kuzi mn, maszt 12 m
TECHNIKA I AUTONOMIA:
- Baterie 200 kWh, Uktadt Klimatyzazzjjonj
- Klimatyzeitylacji, NBC, deployed, Filit.
BEZPIECZEŃSTWO:
- Zeroize, Kamera z Zercory
UZBROJENIE:
- Bezzalogowa Wieża Defensywną, CKM 12,7 mm
1 - Stanowisko Kierowcy
2 - Stanowisko Dowódzy Wozu "PRZYCISK "ZEROIZE"
3 - Stanowisko Operatora Systemów Łączności
4 - Stanowisko Oficera Sztabowego (side-facing)
5 - Stanowisko Analityka Danych (side-facing)
6 - Stanowisko Dwuosobowe Boczne
7 - Panoramiczny Monitor 24" MIL-SPEC
8 - Centralny Ekran Multimedialny 50"
(paire per station)
8 - Centralny Ekran Mullitmedialny 50"
9 - Klawiatura i Panel Dotykowy Pyloszczelny
10 - Szafa Rack 19" (servers, routers, encryptors)
11 - Centralna Jednostka Obliczeniowa (cooled)
12 - Składany Stolik do Map Fizycznych
13 - Drukarka i Skaner Polowy
14 - Automatycznie Rozktadana Antena SATCOM
15 - Hydrauticzny Maszt Teleskopowy 12 m
(deployed state)
16 - Zestaw Akumulatorów (200 kWh) Pod Podtogą
17 - Uktad Klimatyzacji Precyzyjnej (cooled units)
18 - System Filtrowentylacji (NBC) Nadciśnieniowy
19 - Wewnętrzne Kamery Monitoring
20 - Bezzalogowa Wieza Defensywna (CKM 12,7 mm)
21 - Nadbudowa Tylna (+200 mm)
22 - Ekran EMP
23 - Maty Akystyczne
ZALOGA TOTAL: 8 BATERIE: 200 kWh MASZT: 12 m
PROJEKT: CWD-TOR (POJAZD SZTABOWY)
NR ARCH: CWD-TOR-HUL-01
DATA: 10-1998
SKALA:
SKALA: 1:

TOTAL PROTOTYPE COSTS 65.5 million Average 82% Local Content Savings ~45% vs ready-made import.

SAVINGS ANALYSIS (Why so cheap?)
A standard prototype of this class (e.g., American or Korean) would cost approximately PLN 110–130 million. Our price of PLN 65.5 million is based on:
COTS technology: Instead of designing engines from scratch, we take proven units from electric buses and "armor" them (60% lower cost).
Polish Supply Chain: We use ready-made systems (BMS, Optics) that the Ministry of National Defense has already purchased for other programs (no new license costs).
Open Architecture: We build inverters and controllers based on Polish software, which eliminates licensing fees for third parties.

FINANCING AND IMPLEMENTATION STRUCTURE

Phase 1 (6 months): Design and computer simulations (AI Advisor) – 10% of the budget.

Phase 2 (12 months): Hull construction and hybrid drive assembly – 50% of budget.

Phase 3 (6 months): Integration of tower, ASOP systems and state tests – 40% of budget.

RECOMMENDATION FOR THE MINISTER OF DEFENCE
With a series price estimated at PLN 28–32 million (after the completion of the prototype phase), the TOR vehicle is the cheapest and most modern tracked platform in NATO with a hybrid drive.

TOR PROJECT SUMMARY
Character: Heavy transporter / command vehicle (3+8 persons).
Drive: 900 HP series hybrid (COTS technology – civilian adaptation).
Innovations: Silent Drive Mode, AI Tactical Advisor, V2L (mobile power station), ASOP active protection.
Prototype budget: PLN 65.5 million (45% savings thanks to Polish components).
Lead Time: 3 years to prototype, approx. 7 years to full serial production.

Top Secret